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Patentanmeldung Nr. | Patent application No. | Demande de brevet n°

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Bezeichnung der Erfindung/Title of the invention/Titre de l'invention:
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Record carrier comprising an additional sync-colour pattern and method and device for use with such record carrier

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Record carrier comprising an additional sync-colour pattern and method and device for use with such record carrier.

In the current Blu-ray Disc format according to the Blu-ray Disc standard (Blu-ray Disc System Description, Rewritable Format, part 1, Basic Format Specifications) 7 sync-colour patterns, FS0 to FS6, are defined (see Figure 2). These 6 bit sync-colour patterns (6-bit sync ID in Figure 2) comply to the constrains of the 17pp modulation code (d=1, k=7 and RMTR=6). Moreover, for integrity reasons these patterns are chosen such that the Hamming distance between them is greater than or equal to 2.

For certain applications it is advantageous to have an additional 8th sync colour pattern. For example such an additional sync-colour could be required in the extension of the rewritable Blu-ray Disc standard to a ROM (Read Only Memory) version of this standard. Such an additional sync-colour bit pattern would preferably also have to comply with the above mentioned constrains. This appear to be difficult.

It is an object of the present invention to provide such an additional sync-colour bit pattern FS7, in addition to the existing 7 sync-colour patterns, which complies as good as possible to the above mentioned constrains.

This object of the invention is achieved according to a first aspect of the invention when the additional sync-colour pattern FS7 is chosen to be either **100 101** or **010 101**.

This FS7 complies to the channel- and Hamming distance constraints but can generate a RMTR violation as shown in the worst case pattern below:

sync body	FS7	data	
		01 11 01 11	
#01 010 000 000 010 000 000 010	**100 101**	010 101 010 101 000	-> RMTR = 7

Two embodiments are given to overcome this artefact:

First embodiment:

Exclude the source data pattern 01 11 01 11 directly behind FS7.
This will add a small constraint on the source data, but this can easily be incorporated in the format because it will represent an address. When, for example, the first bit of this byte is fixed to a '1' the problem has been solved.

Second embodiment:

Treat the last nibble of FS7 as '11' and do the RMTR substitution according to the 17PP coding rules on the data only.

sync body FS7 data
'11' 01 11 01 11
#01 010 000 000 010 000 000 010 **100 101** 010 101 010 101 000 -> RMTR = 7
substitution 000 000

Now, the channel decoder can detect FS7 and perform the inverse substitution unambiguously.

This object of the invention is achieved according to a second aspect of the invention when the additional sync-colour pattern FS7 is chosen to be either **101 001, 010 100** or **100 100.**

When the constraint of the Hamming distance being greater than or equal to 2 is released , several possible sync-colour patterns become available:

Existing sync colours			Alternatives		
FS0	000 001	(F)	A	101 001	(FS2,I)
FS3	100 001	(B,D)	B	010 001	(FS1,FS3,FS5,FS6)
FS5	001 001	(B,C,E,K)			
			C	001 000	(FS4,FS5,FS6)
FS2	101 000	(A,H)			
FS6	010 000	(B,C)	D	100 010	(FS1,FS3,H)
			E	001 010	(FS1,FS5)
FS1	010 010	(B,D,E,G)	F	000 010	(FS0,FS4)
FS4	000 100	(C,F,K)	G	010 100	(FS1,H,I)
			H	100 100	(FS2,G,I)
			I	100 101	(A,H,J)
			J	010 101	(G,I)
			K	000 101	(FS5,FS4)

In the above table the existing sync-colours FS0 - FS6 are ordered in a systematic way on the left. On the right are the possible additional sync-colours patterns A - K. Between brackets are shown the neighbouring sync-colours pattern which are at a Hamming distance of 1.

Sync-colour patterns A **101 001**, G **010 100** and H **100 100** appear to have a Hamming distance of 1 to only of the one existing sync-colour. These patterns are therefore preferred as additional sync-colour patterns FS7. An additional advantage of these patterns is the lack of a possible RMTR violation.

4.14 17PP Modulation for Rewritable data

All the bits of the Recording Frames except the Frame Sync are converted to modulation bits according to the 17PP modulation code. This is an RLL(1,7) code, with runlengths ≥ 2T and ≤ 8T, and some special properties. PP means: Parity preserve / Prohibit RMTR:

- Parity Preserve: if the number of "1"s in the data bit stream is even, then also the number of "1's in the modulation bit stream is even,
  if the number of "1"s in the data bit stream is odd, then also the number of "1's in the modulation bit stream is odd.

  This property makes it easy to control the low-frequency content of the recorded signal efficiently (see chapter 4.14.2).
- Prohibit RMTR: the number of consecutive minimum runlengths (2T) is limited to 8.
  Because of the low signal levels on minimum runlengths this improves the read-out performance.

4.14.1 Bit conversion rules

The table in Figure 4-20 defines the conversion rules from data bits to modulation bits. The data bits shall be processed from the left to the right (msb's first, see Figure 4-19). Remaining bits at the end of the Recording Frame shall be encoded according to the table for terminating bits.
A "1" in the tables represents a transition in the recorded signal. The modulation bit stream is converted to an NRZI Channel bit stream (see chapter 1.6.2), and subsequently recorded onto the disc.

data bits	modulation bits	
00 00 00 00	010 100 100 100	
00 00 10 00	000 100 100 100	
00 00 00	010 100 000	
00 00 01	010 100 100	
00 00 10	000 100 000	
00 00 11	000 100 100	
00 01	000 100	
00 10	010 000	
00 11	010 100	
01	010	
10	001	
11	000 101	if preceding modulation bits = xx1 if preceding modulation bits = xx0

data bit pattern to be substituted	substituting modulation bits	condition for substitution
11 01 11	001 000 000	if next modulation bits = 010

terminating data bits	terminating modulation bits	
00 00	010 100	
00	000	

Figure 4-20 17PP modulation code conversion table

4.14.2 dc-control procedure

Because a "1" in the modulation bit stream means a transition in the recorded signal, the polarity of this signal can be inverted if an odd number of "1"s is added to the modulation bit stream in a controlled way. Because of the Parity Preserve property of the 17PP modulation code, this is possible just by inserting additional bits into the data bit stream and setting these to "1" if an inversion is needed.
In this way the accumulated DSV of the recorded signal can be minimized after each dc-control block by setting the dc-control bit at the end of the previous dc-control block to "0" or "1" (see Figure 4-19).

4.14.3 Frame Sync

The Physical Clusters consist of 16 Address Units, where each Address Unit contains 31 Recording Frames (see Figure 4-2 and Figure 4-19).
A modulated Recording Frame starts with a Frame Sync consisting of 30 channel bits.
The main body of the Frame Sync is formed by a 24-bit pattern violating the 17PP modulation rules (2 times runlength 9T).
The last 6 bits define a signature, which identify 7 different Frame Sync patterns. The 6-bit signatures for the Frame Sync IDs are selected such that their distance with relation to transition shifts is ≥ 2.

If the last data bits preceding the Frame Sync have been coded according to the termination table (see Figure 4-20), then the first modulation bit of the Frame Sync #=1, else #=0 (see Figure 4-21).
The Frame Sync patterns are defined in terms of modulation bits. A "1" in the table represents a transition in the recorded signal. Before recording onto the disc the Frame Sync codes are converted to an NRZI Channel bit stream (see chapter 1.6.2).

Sync number	24-bit sync body	6-bit sync ID
FS0	#01 010 000 000 010 000 000 010	000 001
FS1	#01 010 000 000 010 000 000 010	010 010
FS2	#01 010 000 000 010 000 000 010	101 000
FS3	#01 010 000 000 010 000 000 010	100 001
FS4	#01 010 000 000 010 000 000 010	000 100
FS5	#01 010 000 000 010 000 000 010	001 001
FS6	#01 010 000 000 010 000 000 010	010 000

Figure 2, 30-bit Frame Sync codes

Because 7 different Frame Syncs are insufficient to identify 31 Recording Frames, each frame is identified by the combination of its own Frame Sync and the Frame Sync of one of the preceding Recording Frames. The mapping of these combinations can be made such, that even with missing Frame Syncs in 1, 2 or 3 preceding frames, a Recording Frame can still be identified by its own Frame Sync and the last present Frame Sync (see Figure 4-22).

Rec. Frame n–4	Rec. Frame n–3	Rec. Frame n–2	Rec. Frame n–1	Rec. Frame n
Recording Frame n can be identified from the Frame Sync IDs of: Recording Frame n + Recording Frame n–1 Recording Frame n + Recording Frame n–2 Recording Frame n + Recording Frame n–3 Recording Frame n + Recording Frame n–4				

Figure 3. Identification of Recording Frames

The first Recording Frame of each Address Unit has a unique Frame Sync: FS0.
The other Frame Syncs are mapped as specified in Figure 4-23.

Frame number	Frame Sync	Frame number	Frame Sync
0	FS0		
1	FS1	16	FS5
2	FS2	17	FS3
3	FS3	18	FS2
4	FS3	19	FS2
5	FS1	20	FS5
6	FS4	21	FS6
7	FS1	22	FS5
8	FS5	23	FS1
9	FS5	24	FS1
10	FS4	25	FS6
11	FS3	26	FS2
12	FS4	27	FS6
13	FS6	28	FS4
14	FS6	29	FS4
15	FS3	30	FS2

Figure 4-23 Mapping of the Frame Sync codes on the Recording Frames

CLAIMS:

1. Record carrier comprising information according to a format in which seven sync-colour patterns are defined, characterised in that the format comprises an additional sync-colour pattern which additional sync-colour pattern is one of **100 101** or **010 101**.

2. Record carrier comprising information according to a format in which seven sync-colour patterns are defined, characterised in that the format comprises an additional sync-colour pattern which additional sync-colour pattern is one of **101 001**, **010 100** or **100 100**.

3. Method of recording to or retrieving information from a record carrier according to claim 1 or 2.

4 Device for recording to or retrieving information from a record carrier according to claim 1 or 2.

ABSTRACT

The invention relates to a format on an optical recording medium, which format comprises an additional 8th sync-colour pattern chosen from **100 101, 010 101, 101 001, 010 100** or **100 100.**